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Cooperative Range Research Program
Montana Agricultural Experiment Station
and
Forage and Range Section, A.R.S. U.S.D.A.
Bozeman, Montana

Introduction

There are at least 100 million acres of rangeland in the West in need of reseeding to protect watersheds, to increase production, and to relieve pressure on heavily overgrazed areas. In Montana over 3 million acres of rangeland are in need of revegetation. Another 2 million acres of marginal cropland would also benefit if adapted species of grasses and legumes were known. Many reseeding failures have resulted from lack of knowledge of soil and seedbed conditions as well as proper management of reseeded areas. At higher elevations and in areas of low precipitation or otherwise adverse conditions, the problems are particularly pressing. In southwestern Montana, there are approximately 100 thousand acres of highly abused and deteriorated subalpine rangeland. High altitude rangelands are vital for control and storage of water. An adequate vegetative cover must be maintained in order to retard erosion and improve the water-holding capacity of the soil.

One of the biggest problems is to determine which species or combinations of species is best adapted and will be productive, persistent, and of high quality. The management given a species or mixture during the evaluation period is extremely important since performance is so greatly dependent upon type of management.

Cooperators:

The pasture and range work in Montana is a cooperative effort of the Forage and Range Section, Field Crops Research Branch of the Agricultural Research Service and Montana Agricultural Experiment Station with the Forest Service, U. S. Department of Agriculture; Bureau of Land Management, U. S. Department of Interior; and various County Extension Agents and farm operators.

The Montana Agricultural Experiment Station provides land, use of machinery, clerical help, office space, and part of the funds used to conduct the work.

The Forage and Range Section provides technical personnel, equipment, supplies and funds for operation of the projects.

The Forest Service provides land and aids in the field work of certain projects. Part of the high altitude and reseeding studies were started by the Forest Service. Later these projects were transferred to A.R.S.

Acknowledgment is given to the Northern Rocky Mountain Forest and Range Experiment Station for laying the foundation and starting these investigations.

The Bureau of Land Management provides land, aids in field work, and provides available supplies for establishing and maintaining certain experimental plots.

The County Extension Agents and farm operators cooperate in the establishment and maintenance of numerous adaptation nurseries.

FCc9-2: Evaluation of Grasses and Legumes Alone and in Combination for Adaptation to Range Conditions.

Adaptation of Grasses for Hay Production under Arid and Semi-arid Conditions

Eight grass species and varieties were seeded October, 1950 in 4 replicates at Fort Ellis, Montana. Plots are 5 feet by 20 feet.

Hay yields for 1952 through 1956 are given in table 6. The highest yield for all grasses was had in the second harvest year. Production has declined each year since 1953.

Lincoln smooth bromegrass was the highest yielder over the five year period, however, it has declined in yield more than the other grasses. The 1955 data showed Sherman big bluegrass and intermediate wheatgrass to be about equal and above Lincoln brome in production.

Differences between species were highly significant in 1956. Sherman blue dropped in yield and standard crested wheatgrass and intermediate wheatgrass were high producers.

Nordan crested wheatgrass returned greater yields than the standard variety from 1952 through 1955 but produced less hay in 1956. The five year average favored Nordan with production 80 percent greater than the standard variety.

Kentucky bluegrass has invaded most of the plots and may be responsible for part of the decline in yield. This is particularly true of all the wheatgrass plots. Bluegrass has only slightly invaded the brome plots. The reduced yield from smooth bromegrass is apparently due to a nitrogen deficiency.

The yields of grasses from Broadwater County, Montana are also presented in table 6. Yields of like species are considerably lower at Broadwater than at Fort Ellis. Precipitation is likewise much lower with 10- and 18-inch annual precipitation respectively. The 7- and 14-inch row spacings had only a slight effect on yield per acre. Generally a higher yield was shown on the 7-inch spacings, but differences were non-significant.

Table 6. Yield of grasses for hay production under dryland conditions. Values are in tons/acre of oven-dry herbage.

Species	Fort Ellis - Gallatin County seeded October, 1950						Broadwater County seeded Spring, 1954				
							1955		1956		
	1952	1953	1954	1955	1956	Ave.	7"	14"	7"	14"	Ave.
Intermediate wheatgrass	2.63	4.00	2.01	1.59	1.01	2.25	0.50	0.40	0.42	0.30	0.40
Tall wheatgrass	1.27	2.58	1.52	0.88	0.62	1.37	0.12	0.03			
Pubescent wheatgrass	2.02	2.85	1.57	1.12	0.74	1.66	0.51	0.48	0.42	0.51	0.48
Standard crested wheatgrass	1.70	3.32	1.70	1.13	1.02	1.77					
Nordan crested wheatgrass	2.66	4.04	2.18	1.40	0.77	2.21	0.63	0.52	0.46	0.38	0.50
Sherman big bluegrass	2.06	3.41	1.73	1.60	0.87	1.93					
Russian wildrye	0.96	2.29	0.68	0.78	0.40	1.02	0.16	0.10	0.08	0.06	0.10
Lincoln smooth brome	3.32	5.06	1.76	1.37	0.90	2.48					
Green stipagrass							0.28	0.33	0.25	0.20	0.26
L. S. D.	0.78	0.85	0.31	0.34	0.19						

SPECIES ADAPTATION UNDER SUB-ALPINE CONDITIONS
CARROT BASIN, GALLATIN NATIONAL FOREST, MONTANA

The high altitude adaptation studies of range plants were started by the U. S. Forest Service.

In the fall of 1952, seven grass species were seeded on severely eroded, high altitude rangeland of the Gallatin National Forest. Six methods of seedbed preparation, three sites, and two methods of seeding were also included in this experiment. Plot treatments were in two replicates. The results of methods are presented and discussed under line project FCc9-3, beginning on page 41 of this report.

Stand success of species was recorded in 1953 by number of seedlings per square foot. In 1954, herbage yields were measured on plots plowed and disked and on plots disked three times. Stands for the other methods of seedbed preparation were considered failures. The 1953 and 1954 data are given in the 1955 annual report.

An ocular estimate of percent stand was made September 11, 1956, and is shown in table 7. The response to site conditions varied by species. Meadow foxtail and smooth bromegrass appear to be the better species suited for an all around seeding program and especially best suited for the north-facing slopes. Bearded wheatgrass has given good stands on some south-facing slopes, but was a complete failure on north-facing slopes. In general, better stands were established on the south-facing slopes than level sites and better on the level than on north slopes. A comparison of the 1953 seedling count and the 1956 stands indicate the affect of microclimatic conditions of slope on stand establishment of the various grasses. Seedling emergence in 1953 was greater on level and north-facing slopes than on south

exposures. This may have been caused from better moisture and temperature conditions on the level and north exposures during germination and seedling emergence. In 1956 the stands were better established on the south-facing slopes. This would indicate that many of the seedlings on the level and north sites were winter-killed, hence, reduced stands on these areas. This interpretation is partially supported by forage yields taken in 1954. Yields were highest on south exposures and lowest on north exposures which correlates with the 1956 stand estimates. It is conceded that other factors than stand could be and undoubtedly were responsible for the higher yields. The influence of soil temperature and length of growing season as affected by slope undoubtedly affected the 1954 herbage production.

The comparative rank of species in success of establishment is given in table 8. After three growing seasons meadow foxtail has moved ahead of smooth bromegrass and Kentucky bluegrass has moved from lowest in 1953 to fourth rank in 1956. Mountain brome and California brome have consistently rated low with California brome dropping to last place in 1956.

The plots had been grazed by sheep during August, 1956. Grazing was particularly heavy on smooth brome and meadow brome. Plants of meadow foxtail, Kentucky bluegrass and bearded wheatgrass were only lightly grazed while mountain brome and California brome were moderately grazed. Because of grazing no yields were taken.

Table 7. Percent stand of grass species under sub-alpine conditions as affected by site. Carrot Basin, 1956*. Stands were seeded 1952.

Species	Site exposure			
	level	south	north	average
		(Percent stand)		
Smooth brome	16.6	11.7	9.3	12.53
Bearded wheatgrass	2.8	12.7	0.0	5.17
Meadow foxtail	13.1	14.8	10.0	12.63
Kentucky bluegrass	7.0	6.7	1.0	4.90
Mountain brome	1.6	6.0	1.2	2.93
California brome	0.7	2.8	2.0	1.83
Meadow brome	5.0	6.8	0.8	4.20
Average	6.68	8.76	3.48	

L. S. D. 5% for site exposure non-significant.

*Note: Values are averages for all plot treatments. Values comparing species by site and seedbed preparation methods are given in table 11.

Table 8. Establishment of grass species under sub-alpine conditions of Carrot Basin after four growing seasons. Species are ranked according to number of seedlings per square foot in 1953 and percent of stand in 1956. Plots were seeded in 1952.

Species	Establishment Rank	
	1953	1956
Meadow foxtail	2	1
Smooth bromegrass	1	2
Bearded wheatgrass	3	3
Kentucky bluegrass	7	4
Meadow bromegrass	4	5
Mountain bromegrass	6	6
California bromegrass	5	7

SPECIES ADAPTATION AND LONGEVITY AT HIGH ALTITUDES. LAZYMAN HILL, BEAVERHEAD NATIONAL FOREST

Forty species of grasses and legumes were seeded by the U.S. Forest Service, July 7, 1942, on a fertile south-southwest exposure at Lazyman Hill. Elevation is 9,350 feet above sea level.

Observations of seedling stands were made in the fall of 1942. Stand data was taken from 1942 through 1946 and again in 1950, 1951, and 1955. Stands were estimated ocularly as the percent of row fully occupied by reseeded plants. It is unfortunate that this study was destroyed by plowing in 1956 to initiate an adaptation and fertilizer study started in September, 1956.

A report of this study was made by R. A. Peterson and presented in the Journal of Range Management. Vol.6 (4): 240-247.1953. The article summarizes the data through 1951.

The stand data are given in table 9. The smooth brome varieties, meadow foxtail and Kentucky bluegrass appear well adapted to the high altitude and spread beyond the plot borders. Plots of slender and violet wheatgrasses were heavily infested with smooth brome to the extent that only traces of the wheatgrasses were found. Evidently this invasion by bromegrass was accomplished since 1951. At that time stands of 70 and 90 percent were recorded for the wheatgrasses.

Kentucky bluegrass had spread considerably by 1955, however, areas of dead plants indicated that a disease, possibly snow-mold, had killed some plants. Meadow foxtail plants were scattered throughout the plots. The ability to produce seed and reseed itself under the short growing season of this area makes meadow foxtail one of the better species for reseeding in high altitude areas.

Table 9. Stands of species at a high altitude nursery. Lazyman Hill, Montana. Plots were seeded in July, 1942 and plowed out August, 1956.

Species	Percent stand				
	1943	1944	1946	1951	1955
Commercial smooth brome	95	95	100	100	95
Parkland smooth brome	90	95	100	90	95
Meadow foxtail	70	80	95	95	80
Meadow brome	90	90	95	100	60
Kentucky bluegrass	40	40	90	100	80
Violet slender wheatgrass	95	95	100	90	T
Slender wheatgrass	95	95	100	70	T
Bearded wheatgrass	95	95	100	80	T
Hard fescue	75	75	90	50	T
Thickspike wheatgrass	90	80	90	75	90
Fairway crested wheatgrass	80	75	90	40	25
Red fescue	75	75	90	75	40
Russian wildrye	90	80	80	70	50
California brome (native)	80	80	90	25	T
Intermediate wheatgrass	95	95	80	10	T
Western wheatgrass	65	ok	80	20	T
Perennial barley	80	75	85	25	T
Virginia wildrye	80	80	90	25	T
Dahurian wildrye	95	80	90	20	T
Siberian wildrye	75	80	95	10	0
Timothy	85	90	90	10	T
Standard crested wheatgrass	80	70	60		20
Birdsfoot deervetch	90	75	85	T	0
Meadow fescue	25	95	50		T
Rough fescue	5	T	5	5	T
Idaho fescue	40	T	10	3	T
Redtop	55	40	15		0
Bluebunch wheatgrass	90	50	10		0
Siberian wheatgrass	65				0
Beardless wheatgrass	50				0
Tall oatgrass	30	25	15		0
Canada bluegrass	40				T
Big bluegrass	T				T
California brome (introduced)	5	T			0
Orchardgrass	80	25	15		0
Yellow sweetclover	90	75			0
Red clover	70				0
Strawberry clover	90				0
White clover	40	T			0
Clover spp. (native)	T				T

FERTILIZATION INFLUENCES ON NATIVE RANGELAND IN MONTANA

In 1956, fifteen fertilizer treatments were applied to rangeland in southwestern Montana. Major vegetative complexes, soils, and elevations at four locations were represented in the study. The experiment was designed to run through 1960 with fertilizer treatments applied so that the carry-over and accumulative affects of fertilizers for one to four years can be determined. The effect of fertilizer treatments are to be determined from herbage yield, change in vegetative composition, and morphological differences within species. Plots are 10 feet wide by 100 feet long. Sub-plots of treatments by years are to be 10 feet by 25 feet.

The fertilizer treatments consist of the following rates and combination of fertilizers

Treatment number	Pounds per acre N	+	P_2O_5
1	0		0
2	50		0
3	100		0
4	200		0
5	400		0
6	0		20
7	50		20
8	100		20
9	200		20
10	400		20
11	0		80
12	50		80
13	100		80
14	200		80
15	400		80

Three Forks: On the Pete Tocci Ranch at Three Forks, Montana, fertilizer treatments were applied April 12, 1956 to native range of a bluegrass - stipa - wheatgrass - sedge vegetative complex. The elevation is approximately 4500 feet above mean sea level. Fertilizer treatments were replicated 4 times.

Herbage was clipped to a two-inch stubble June 25, 1956. Yields are shown in figure 1 as pounds per acre on an oven-dry basis. Though differences between fertilizers were non-significant, a definite response to application of nitrogen was noted. Plots receiving nitrogen were greener in color and remained green from 2 weeks to a month longer than plots which did not receive nitrogen. The variation in distribution of species over the area and between replications greatly increased the variability within the experiment and was at least partially responsible for the non-significance of treatment differences.

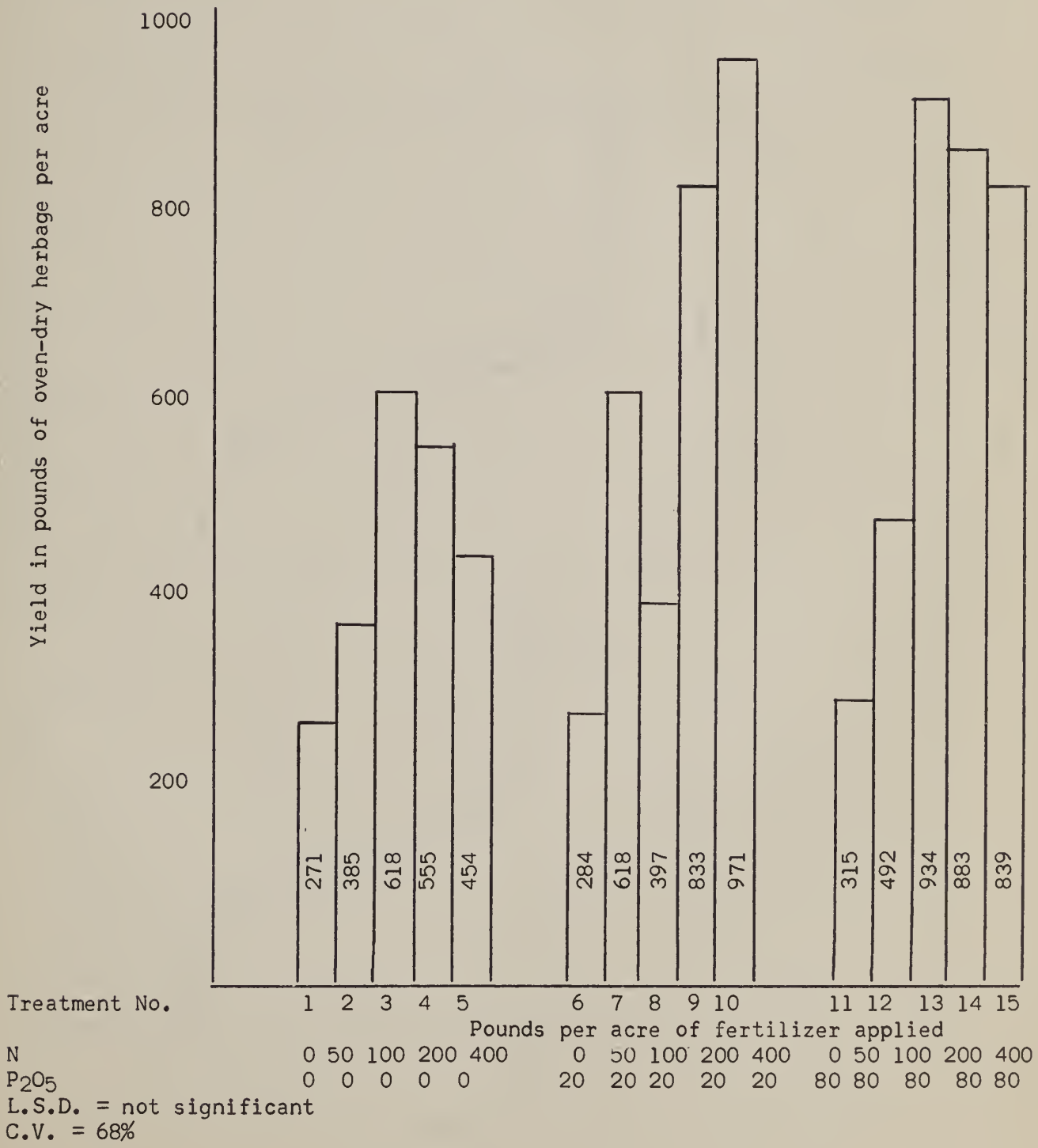
The treatment means would indicate a positive response to fertilization. When nitrogen was applied alone, treatments 1 - 5, yield was increased with increased rates of application up to 100 pounds per acre but decreased with increasing rates above 100 pounds. The same trend was indicated from treatments 11 - 15 when nitrogen was applied with 80 pounds of P_2O_5. Though treatments 4 and 5 were below treatment 3 and 14 and 15 were below treatment 13, they yielded more than treatment 2 or 12 with 50 pounds of nitrogen.

It is not known why the yields from treatment 8 reduced yield below that for 7 and 9. All plots in each of the four replicates showed the same trend. It is possible that the combination of 100 pound N with 20 pounds P_2O_5 (treatment 8) is near a critical level where soil organisms were activated to the extent that they utilized most of the available nitrogen. At lower rates of N the critical level may not have been reached. At higher levels the organisms may have been activated, but the rate of application was high enough that some nitrogen was available for plant growth.

For maximum production both nitrogen and phosphorus were required. The data would indicate that treatment 10 (400 pounds N with 20 pounds P_2O_5) produced the maximum forage -- an increase from 271 to 971 pounds per acre.

The species most affected by fertilization was sandberg bluegrass. Growth of this grass was greatly increased from addition of nitrogen, particularly in the size of panicles. A measurement of this response was not made. The height response of the plants was measured at intervals during the growing season and shown in figure 2. All application of fertilizers caused an increase in plant height.

Figure 1. Herbage yield of fertilized native range. Tocci Ranch, Three Forks, Montana, 1956.



L.S.D. = not significant
C.V. = 68%

Figure 2. Effect of fertilizer treatments on height of Sandberg bluegrass.

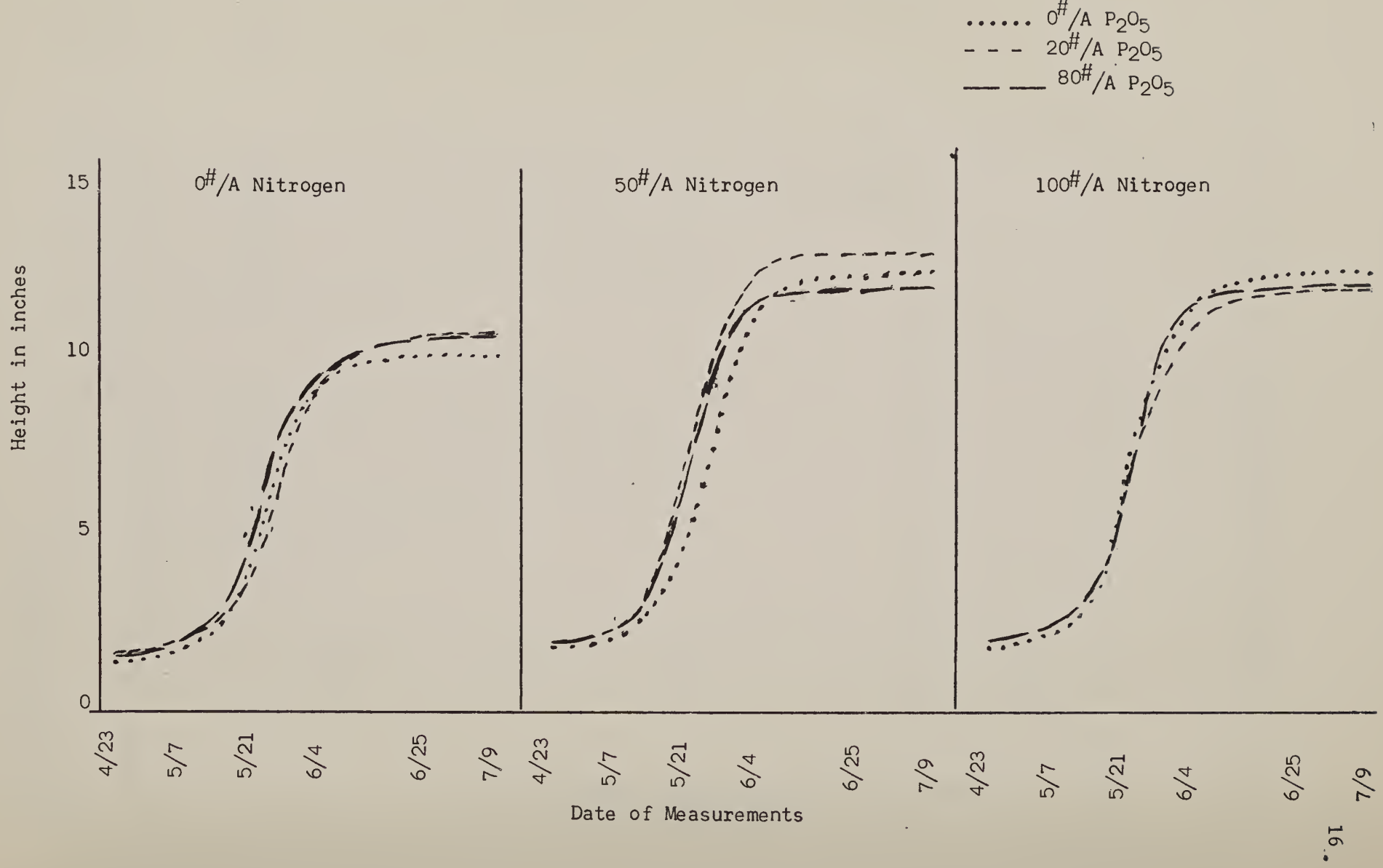
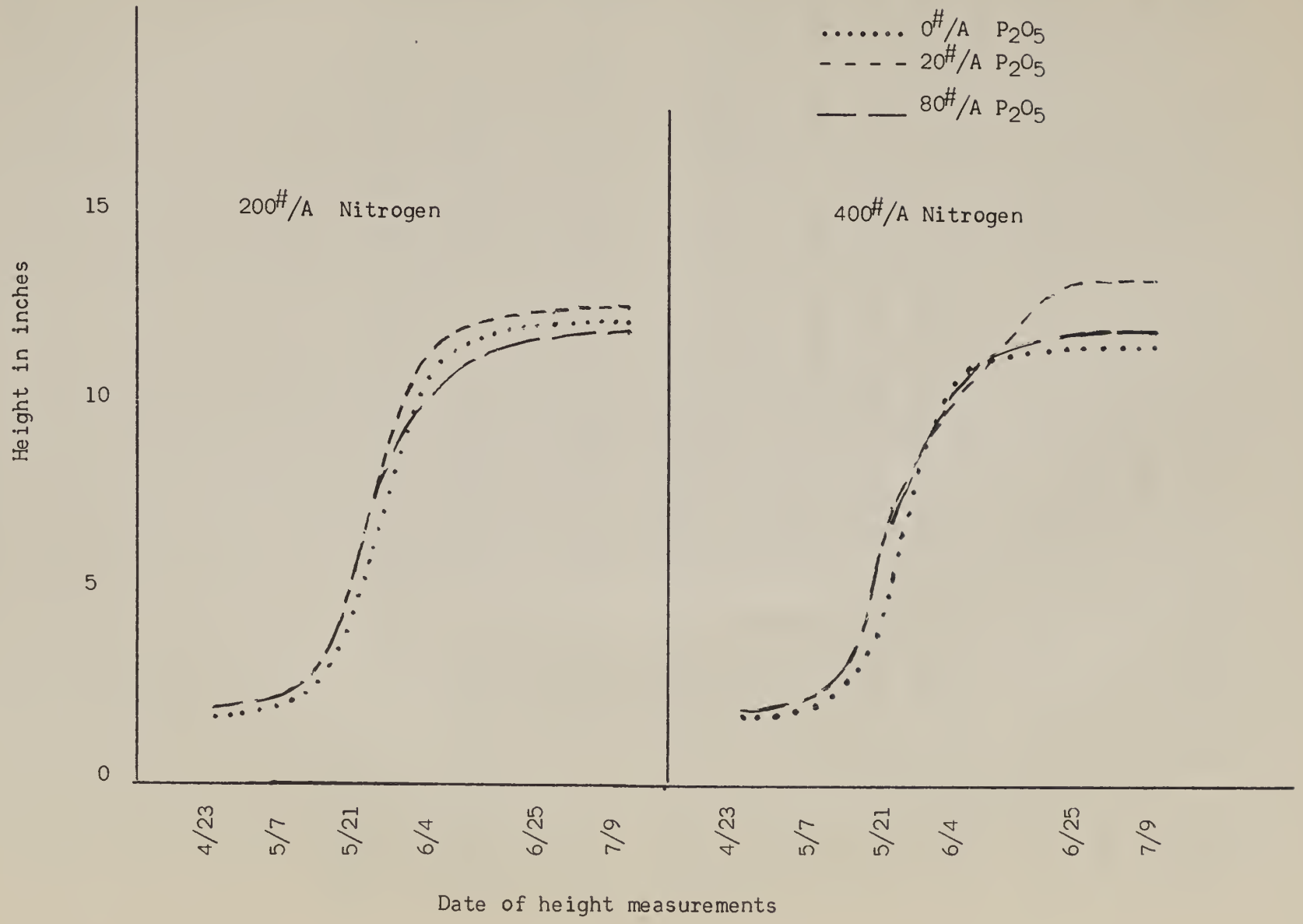


Figure 2. (continued) Effect of Fertilizer treatments on height of Sandberg bluegrass.

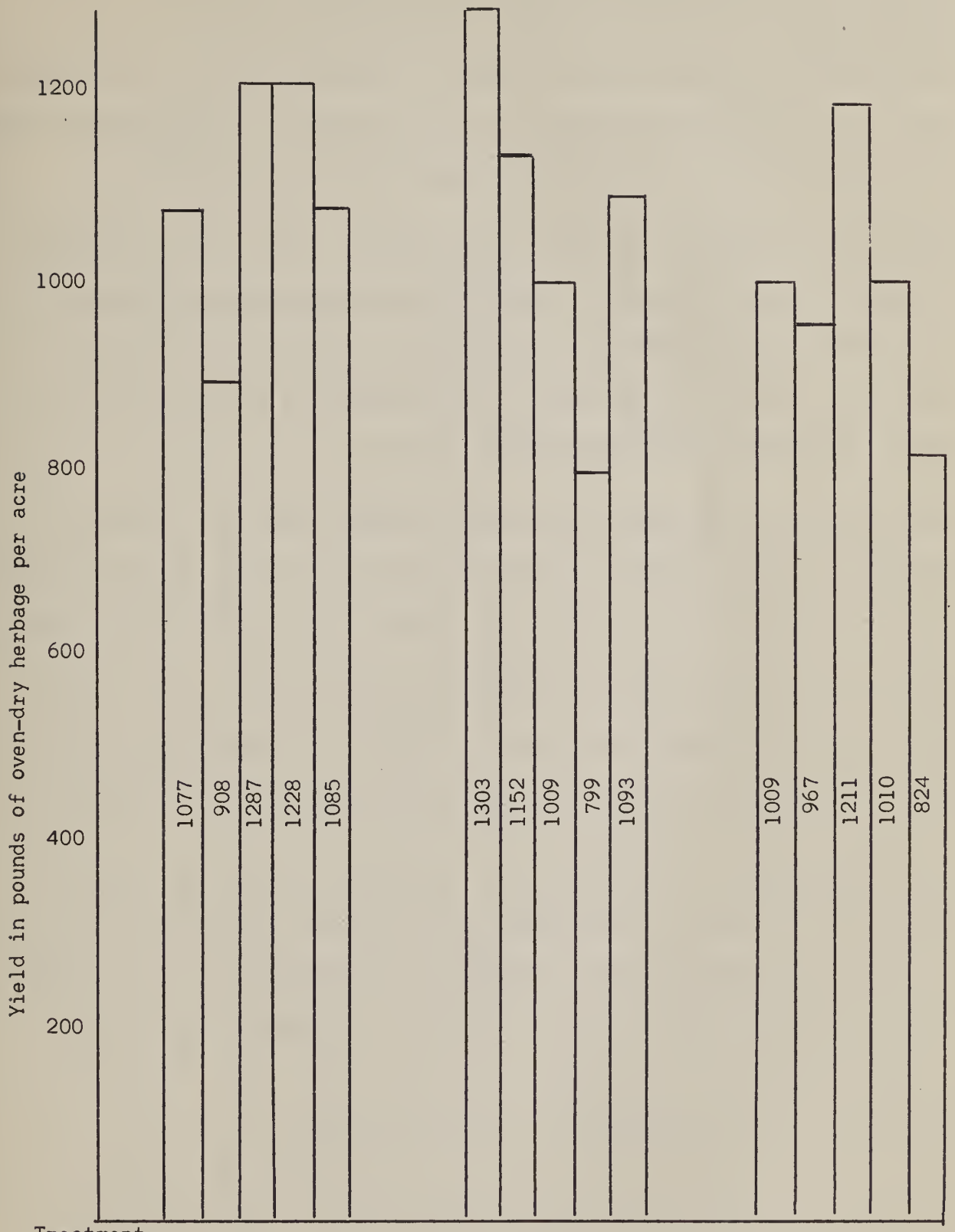


Ennis: On rangeland operated by Stewart Garard, 12 miles south of Ennis, Montana, fertilizer treatments were applied June 6, 1956 to native range of stipa - wheatgrass - sedge vegetative complex. The elevation is approximately 5,500 feet above mean sea level. Treatments were applied in 3 replicates.

Herbage was clipped at a 2-inch stubble July 24, 1956. Though yield differences were highly significant between treatments, no color differences were observed. Apparently the fertilizers were not applied early enough in the growing season to be utilized by the growing plants. Precipitation was low after treatment and much of the fertilizer pellets remained undissolved for several weeks. This lack of moisture may have been responsible for the failure of plants to show positive response.

The comparative yields shown in figure 3 are not readily explainable, particularly yields from plots treated with P_2O_5 at 20 pounds per acre. It would appear that the trend in production is reverse to what would normally be expected from fertilizer treatments. This apparent reversal may have been caused from a detrimental affect of nitrogen during the period of low precipitation.

Figure 3. Yield of native rangeland as affected by fertilizer treatment, Ennis, Montana.



L.S.D. = 148 at 5% level. C.V. = 18%.

Crockett Lake: Fertilizer treatments were applied May 18, 1956 to native vegetation of a fescue-wheatgrass complex. Plots are located on the Gravely Range of the Beaverhead National Forest at an elevation of approximately 7500 feet above sea level. Treatments were applied in 3 replicates.

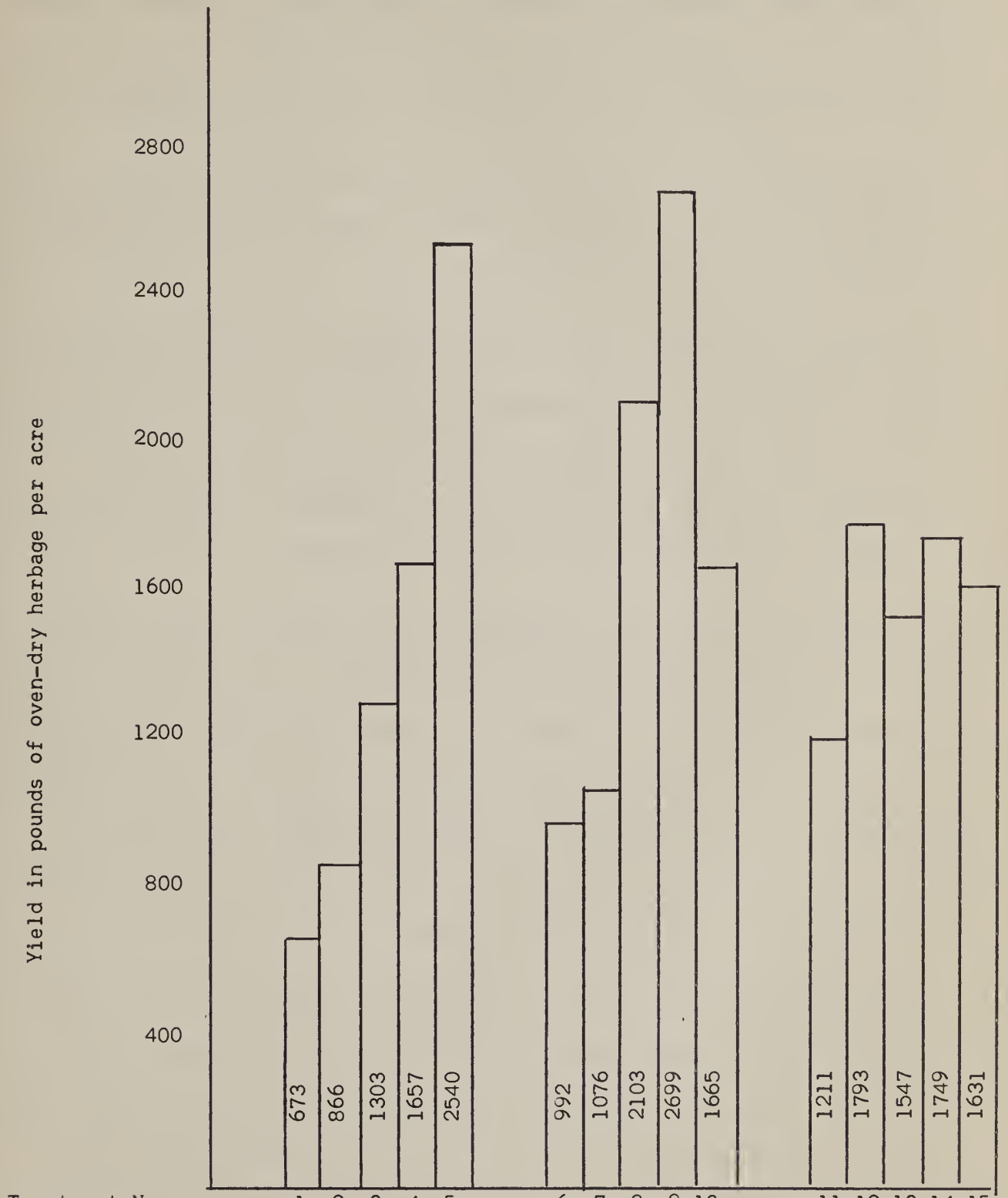
Herbage was clipped to a two-inch stubble July 25, 1956. Yields in pounds per acre are given in figure 4. Treatment differences were significant. The maximum yield of 2,699 pounds per acre was produced from treatment 9 (200 pounds N with 20 pounds P_2O_5). This increase was 400 percent of the control treatment with only 673 pounds per acre.

Plots treated with nitrogen alone showed increased yields with increased rates of nitrogen. Treatment 10 with 400 pounds of nitrogen increased yields from 673 to 2540 pounds per acre -- an increase of 377 percent of the control.

Apparently the application of 80 pounds P_2O_5 increased yields when applied alone and with 50 pounds N, treatments 11 and 12, but dropped below treatment 12 when heavier rates of N was applied in treatments 13, 14, and 15.

The color response of the vegetation to application rates of nitrogen was striking. The intensity of the green color increased with increased rates of N. Plots which did not receive nitrogen were light green in color and dried from 4 to 6 weeks earlier than the more heavily nitrogen fertilized plots.

Figure 4. Yield of native rangeland as affected by fertilizer treatment. Crockett Lake, Beaverhead National Forest, Montana.



L. S. D. = 465.1 at 5% level
C. V. = 39%

Lazyman Hill: Fertilizer treatments at Lazyman Hill were applied June 26, 1956 on native range of a fescue-wheatgrass-forb complex. The elevation is 9350 feet above mean sea level. Treatments were made in 3 replicates.

Herbage was clipped to a 2-inch stubble August 28, 1956. Yields are shown in figure 5 in pounds per acre of oven-dry herbage. Differences between treatments were highly significant.

All nitrogen treatments showed a positive response but the application of 80 pounds P_2O_5, treatment 11 apparently caused a reduction in yield below the control treatment. Maximum yield was obtained from treatment 14 (200 pounds N with 80 pounds P_2O_5) with 1284 pounds of forage. This was an increase of 181 percent of the control treatment.

The week before yields were determined, several inches of early snow had fallen and night temperatures were below freezing. The vegetation, however, remained green. The color response to nitrogen was evident through August. At the time the herbage was clipped, plots which did not receive nitrogen were yellowish green in color while plots receiving nitrogen were dark green. The intensity of green color as related to rates of application at Crockett Lake were not as evident at Lazyman Hill.

The application of heavy rates of nitrogen had a detrimental affect on plants of Idaho fescue. The 400 pound rate caused severe burning of the leaves and completely killed many of the plants. Other species apparently were not injured by this high rate. This loss of plants may be partially responsible for the decline in yield on plots receiving 400 pounds N as compared to plots receiving 200 pounds.

Figure 5. Yield of native range as influenced by fertilizer treatment. Lazyman Hill, Montana.

Treatment No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Pounds per acre of fertilizer applied														
N	0	50	100	200	400	0	50	100	200	400	0	50	100	200	400
P_2O_5	0	0	0	0	0	20	20	20	20	20	80	80	80	80	80

L.S.D. = 125.9 at 5% level
C. V. = 18%

FERTILIZATION OF RESEEDED GRASSES

Fertilized strips across reseeded plots at Three Forks, Montana, did not give a clear picture of response to the fertilizers applied, table 10. The design lacked replication of treatments and therefore was not statistically sound. On a sampling basis slight difference was shown between fertilizers and between drill-row spacings but were not consistent.

The different grasses appeared to respond differently to nitrogen and phosphorus fertilizers. It would appear that phosphate decreased yields of the wheatgrasses but increased yield of green stipa grass while nitrogen decreased yields of stipa.

Visual observation of the fertilized plots showed a striking response to nitrogen particularly by Nordan crested wheatgrass. Culms of crested wheatgrass were slightly longer on fertilized plots, seed heads appeared heavier, and plants retained a green color two weeks longer than plants on unfertilized strips. The nitrogen fertilizer stimulated growth of intermediate wheatgrass early in the growing season but caused the leaves to burn and dry as moisture became critical in early summer.

A striking response of cheatgrass and Russian thistle was also noted. On nitrogen fertilized plots the growth of these two annual weeds was greatly increased. They appeared much more robust and vigorous, however, no measurements were made on these weeds.

Since the results of this study are confusing and the design does not lend itself well to statistical analysis, a carefully planned experiment should be made.

Table 10. Yield of fertilized grass species planted at 7-inch and 14-inch row spacings under dryland conditions. Forage clipped to two-inch stubble. Tocci Ranch, Three Forks, Broadwater County, Montana.

Species	Row spacing in inches	Fertilizer treatment lbs./acre						
		0 N 0 P_2O_5	100 N 40 P_2O_5	200 N 0 P_2O_5	75 N 0 P_2O_5	50 N 0 P_2O_5	50 N 40 P_2O_5	0 N 40 P_2O_5
		(Yield Tons per Acre)						
Intermediate wheatgrass	7	.42	.40	.47	.51	.38	.36	.38
	14	.30	.18	.50	.24	.22	.34	.23
Russian wildrye	7	.08	.25	.16	.13	.16	.06	.08
	14	.06	.08	.04	.06	.07	.06	.06
Pubescent wheatgrass	7	.42	.94	.44	.60	.41	.31	.29
	14	.51	.31	.26	.65	.46	.51	.48
Green stipa grass	7	.25	.22	.21	.12	.18	.44	.39
	14	.20	.36	.26	.16	.34	.39	.23
Nordan crested wheatgrass	7	.46	.65	.64	.61	.68	.48	.52
	14	.38	.62	.60	.72	.58	.59	.40

FCc9-3: Establishment Practices for Revegetation of Range Areas in the West.

The Affect of Methods of Seedbed Preparation and Seeding on Species Establishment under Sub-alpine Conditions

Carrot Basin, Gallatin National Forest, Montana

In the fall of 1952, the U. S. Forest Service began a study to test equipment and methods for reseeding inaccessible high altitude areas. The study included six methods of seedbed preparation and two methods of seeding in two replicates on three sites. Seven grass species were used to test each treatment. (see FCc9-2, page 21 for presentation and discussion on species adaptation).

Results in stand establishment was measured by number of seedlings per square foot in 1953, herbage yield in 1954, and percent stand in 1956. The 1953 and 1954 data are presented in the 1955 annual report.

An ocular estimate of stand in 1956 showed a highly significant difference between seedbed preparation treatments, table 11. Very poor establishment was obtained on plots where the soil was not well prepared and where vegetative competition from native species was not greatly reduced. Though slight variations occurred by species, generally, plowing with disking was superior to disking while disking three times was superior to disking twice or once.

Seeding methods under the conditions of this experiment showed very little difference in stand establishment, table 12.

Table 11. Percent stand of species under sub-alpine conditions as affected by site and seedbed preparation. Carrot Basin, 1956.

Method seedbed preparation	Site Exposure	Smooth brome	Bearded wheatgrass	Meadow foxtail	Kentucky bluegrass	Mountain brome	California brome	Meadow brome	Ave.
Plow x disk	level	52.5	6.2	21.2	16.2	4.2	0.5	6.5	15.3
	south	18.8	32.5	30.0	10.0	15.0	10.2	15.0	18.8
	north	11.2	0.0	18.8	1.0	2.8	7.5	1.2	6.1
	ave.	27.5	12.9	23.3	9.1	7.3	6.1	7.6	13.4
Disc 3 x	level	11.2	4.0	28.5	13.5	2.5	0.5	10.0	10.0
	south	24.0	20.0	22.5	17.8	4.0	4.2	12.5	15.0
	north	10.0	0.0	16.2	0.8	0.8	2.0	1.0	5.4
	ave.	15.1	8.0	22.4	10.7	2.4	2.2	7.8	9.8
Disc 2 x	level	30.0	2.0	17.5	6.2	0.5	2.5	3.0	8.8
	south	15.0	12.5	21.2	7.8	2.0	1.5	6.5	9.5
	north	20.0	0.0	18.8	2.0	0.8	0.2	0.8	7.1
	ave.	21.7	4.8	19.2	5.3	1.1	1.4	3.4	8.1
Disc 1 x	level	1.2	1.8	5.2	2.0	0.5	0.2	2.8	2.0
	south	6.5	4.0	6.2	1.0	3.0	0.5	2.0	3.3
	north	10.2	0.0	3.5	1.0	0.8	0.5	0.5	2.4
	ave.	6.0	1.9	5.0	1.3	1.4	0.4	1.8	2.5
Horse disc	level	3.8	2.0	5.2	3.0	1.5	0.2	4.0	2.8
	south	5.2	6.5	6.5	3.0	5.5	0.0	2.8	4.2
	north	6.2	0.0	2.0	0.8	1.0	1.0	1.0	1.7
	ave.	5.1	2.8	4.2	2.3	2.7	0.4	2.6	2.9
Control	level	0.8	0.5	0.5	0.8	0.5	0.2	0.5	0.5
	south	0.5	0.5	2.5	0.5	4.0	0.0	0.5	1.2
	north	2.0	0.0	0.8	0.8	1.0	0.5	0.5	0.8
	ave.	1.1	0.3	1.3	0.1	1.8	0.2	0.5	0.8
Sp. Average		12.53	5.17	12.63	4.90	2.93	1.83	4.20	

Table 12. Percent stand of grass species under sub-alpine conditions as affected by seeding methods, 1956*.

Species	Seeding Method		
	Drilled	Broadcast	Average
Smooth brome	12.5	12.5	12.5
Bearded wheatgrass	4.1	6.1	5.1
Meadow foxtail	11.7	13.6	12.6
Kentucky bluegrass	6.2	3.6	4.9
Mountain brome (marginatus)	3.8	2.1	2.9
Mountain brome (carinatus)	2.4	1.2	1.8
Meadow brome	4.4	4.0	4.2
Average	6.43	6.19	

L.S.D. 5% Seeding methods not significant.

* Note: Values are based on an average of all plot treatments.

RESPONSE OF GRASS SPECIES TO METHODS OF SEEDING AND FERTILIZATION UNDER SUB-ALPINE CONDITIONS - CARROT BASIN

From visual observations in 1955 of the 1952 Carrot Basin study, it was obvious that even the better methods used gave only fair success with considerable variation between replications. Chemical analysis of the top six inches of soil showed the soil to be low in fertility and organic matter.

Based on the results of the 1952 study and the soil analysis, three of the more promising grasses were seeded September 14, 1955, July 9, 1956, and September 11, 1956. At the time of seeding four fertilizer treatments, two fertilizing methods, two seeding methods, and two intensities of seedbed preparation, were also included in the experiment. Plots 3 feet wide and 20 feet long were replicated three times.

By July 9, plots seeded in September of 1955 had germinated. Seedlings of meadow foxtail and smooth brome grass were from 1/2 to 1 inch tall, but seedlings of Kentucky bluegrass were not found.

On September 11, 1956 seedling emergence was determined by number of seedlings per square foot. Meadow foxtail produced a better stand of seedlings on untilled soil, table 13, and on tilled soil, tables 14 and 15.

Though statistical significance was not shown for differences between seeding methods, table 13, it appears that drilling was superior to broadcasting seeds of meadow foxtail and smooth bromegrass. Seeding methods were comparable for Kentucky bluegrass. The size of the seed of these species may be as important as the method of seeding on seedling establishment. The smaller seeds of Kentucky bluegrass may have fallen into soil cracks and were covered with soil whereas the larger seeds of brome and meadow foxtail may not have been covered.

The use of fertilizers at the rates applied showed no significant difference in number of seedlings counted per square foot, table 14. It should be noted however, that in all treatments except Kentucky bluegrass treated with phosphate, the number of seedlings per square foot was less in fertilized plots. It is possible that there may have been a detrimental effect from fertilization at these rates upon the germinating seeds. It is known that high rates of nitrogen fertilizers applied with the seed often causes this type of response.

The fertilizers were applied by broadcasting after seeding and by banding 1 inch below and 1 inch to the side of the seeded rows. The methods used for applying fertilizers did not significantly affect the number of seedings, table 15. Banding was slightly better for meadow foxtail, however, broadcasting fertilizer appeared slightly better for brome grass and considerably better for Kentucky bluegrass.

From the results of this study it is apparent that more basic information on the rates and application of fertilizer is needed.

Table 13. Seedling emergence under sub-alpine conditions of Carrot Basin as affected by seeding methods on untilled soil.

Species	Seeding method		
	Drilled	Broadcast	Average
	(seedlings per sq.ft.)		
Meadow foxtail	5.5	0.4	3.0
Smooth brome	0.5	0.3	0.4
Kentucky bluegrass	1.3	1.4	1.4
Average	3.4	0.7	

L.S.D. Not significant.

Table 14. Seedling emergence under sub-alpine conditions of Carrot Basin as affected by fertilizer treatment on tilled soil.

Species	Fertilizer treatment				
	Nitrogen	P_2O_5	$N+P_2O_5$	Control	Average
Meadow foxtail	15.8	12.4	15.1	19.4	15.67
Smooth brome	1.6	3.2	2.6	3.9	2.82
Kentucky bluegrass	2.5	6.5	3.8	4.5	4.3
Average	6.64	7.37	7.17	9.27	

L.S.D. for species = 5.75 at 5% level.

L.S.D. for fertilizers = not significant.

Note: Fertilizer was drilled in bands. Nitrogen was applied at 100 pounds N per acre and Phosphate was applied at 200 pounds P_2O_5 per acre.

Grass species were drilled at 20 pounds seed per acre in rows 1 inch above and 1 inch to the side of fertilizer bands.

Table 15. Seedling emergence under sub-alpine conditions of Carrot Basin as affected by fertilization methods on tilled soil.

Species	Application Method		Average
	Broadcast	Banding	
	(seedlings per sq.ft.)		
Meadow foxtail	13.8	15.1	14.4
Smooth bromegrass	3.2	2.6	2.9
Kentucky bluegrass	6.8	3.8	5.3
Average	8.0	7.2	

L.S.D. for spp. 9.36 at 5% level of significance.

L.S.D. for application method not significant at 5%.

ESTABLISHMENT OF GRASS SPECIES AS AFFECTED BY METHODS OF TREATING SAGEBRUSH RANGELAND DRY FAWN BENCH, BEAVERHEAD NATIONAL FOREST, MONTANA

This study was initiated by the U. S. Forest Service. Thirteen grass species were seeded by broadcasting in the spring of 1951. Three disking-seeding treatments on sagebrush rangeland with two replicates were included in the study. Plots are 15 feet wide by 58 feet long.

Herbage yields were taken September 15, 1952 and in October, 1954, table 16. Yield differences between species were highly significant in 1952 but were non-significant in 1954.

Yield differences as affected by treatments were highly significant. In 1952 yields from double disked-double seeded and from triple disked-triple seeded plots compared closely, however, considerable variation in species response occurred. Double-disking-double seeding favored production of some species while triple disked-single seeded favored others. In each of the harvest years, yields from single disked-single seeded plots were considerably below those from the more intensively prepared plots.

The 1954 yields were considerably above those of 1952 for most species on single disked plots and were slightly higher on triple disked plots. There were, however, a few species which showed a decline in yield. Orchardgrass was the only species to drop-off in yield on both single disked and triple disked plots.

In 1956 percent stand of species was determined by ocular estimate. Highly significant stand differences were shown between treatment methods, table 17. Lincoln smooth bromegrass, intermediate wheatgrass, and hard fescue appeared best adapted for seeding under the soil and climatic conditions of this study.

Species which probably should not be used extensively for reseeding on sagebrush lands, particularly where seedbed preparation and control of brush are limited, are green stipa grass, orchardgrass, Russian wildrye, and slender wheatgrass. The importance of brush control and elimination of competition from native vegetation is clearly indicated. Generally superior stands were received by the more intensive disking operation.

Table 16. Herbage yield of grass species as affected by methods of treating sagebrush rangeland. Dry Fawn Bench, Beaverhead National Forest. Yields are in air-dry weight pounds per acre.

Species	Single disked Single seeded 1952	1954	Double disked Double seeded 1952	Triple disked Single seeded 1952	1954
Crested wheatgrass	130	886	898	1320	1719
Intermediate wheatgrass	1220	2144	3088	2521	2183
Western wheatgrass	106	1083	1354	749	1587
Slender wheatgrass	672	1102	1556	2795	2322
Pubescent wheatgrass	398	2144	1902	941	2292
Tall oatgrass	283	1592	1148	980	2449
Meadow brome	302	1037	816	1061	2295
Lincoln smooth brome	168	1237	1743	1767	2804
Orchardgrass	855	797	2218	2113	2082
Russian wildrye	38	1289	134	485	1960
Hard fescue	274	1736	1575	1594	2245
Big bluegrass	38	800	192	1263	1107
Green stipa	86	1078	336	418	1606
Average	352	1302	1304	1384	2050

L.S.D., 1952 -- between treatments = 282 at 5% level.
1954 -- between treatments = 579 at 5% level.

C.V. 1954 = 40%.

Table 17. Percent stand of grass species on sagebrush land as affected by land treatment, 1956. Dry Fawn Bench, Beaverhead National Forest, Montana.

Species	Single seeded Triple disked 1/	Double seeded Double disked 2/	Single seeded Single disked 3/	Ave.
Standard crested wheatgress	60	48	28	45.0
Intermediate wheatgrass	93	90	50	77.5
Western wheatgrass	53	50	30	44.2
Slender wheatgrass	63	10	10	27.5
Pubescent wheatgrass	80	70	30	60.0
Tall oatgrass	63	83	10	51.7
Meadow brome	78	70	25	57.5
Smooth brome (Lincoln Variety)	93	90	63	81.7
Orchardgrass	40	13	23	25.0
Russian wildrye	30	3	5	25.0
Hard fescue	80	88	63	76.7
Big bluegrass	65	10	18	30.8
Green stipa grass	33	15	5	17.5
Average	63.65	49.04	27.50	

L.S.D. at 5% level for species = 23.97 highly significant difference.
for land treatment = 21.08 highly significant difference.

1/ 15 percent stand of sagebrush.
2/ 25 percent stand of sagebrush.
3/ 35 percent stand of sagebrush.

REVEGETATION OF SAGEBRUSH LANDS IN THE FOOTHILL AREA OF SOUTHWESTERN MONTANA
HORSE PRAIRIE DRAINAGE, BEAVERHEAD COUNTY, MONTANA

This project was mutually agreed upon between the Bureau of Land Management and the Montana Agricultural Experiment Station and is carried under Memorandum of Understanding dated December 31, 1956. Project leadership is under personnel of the Forage and Range Section, A.R.S.

The project is designed to determine better methods, species, and fertilization practices for reseeding and increasing forage production of sagebrush land and to determine the plant succession of reseeded sagebrush land.

Fertilizer effect upon the establishment and forage value of reseeded species

Thirteen seeding treatments, two fertilizer treatments and two grazing treatments are to be used in this study.

On October 3, 1956, five species seeded alone and in mixtures were drilled on sagebrush land. The brush had been killed and the seedbed prepared with a disc plow. Disking was done early in the summer of 1956. Drilling was with a rangeland drill. The species used were Ladak alfalfa, yellow sweetclover, crested, intermediate, and pubescent wheatgrasses.

After seeding a fertilizer mixture of 50 pounds N and 40 pounds P_2O_5 per acre was applied to one half of the area in such a manner that a fence will divide the fertilized and species blocks into two similarly treated areas. The fertilizer was applied by top dressing.

Adaptation of Species

The fall planting of the adaptation nursery was seeded October 4, 1956. Three rows per species in plots 3 feet by 20 feet were seeded in triplicate. The spring plantings will be made in 1957. Twenty-six species and varieties of selected strains have been seeded. New introductions and superior strains will be tested as they become available.

FCc9-5: Cultural and Management Practices of Native and Reseeded Range Land.

Sagebrush Control and its Influence on Production and Utilization of Range Forage Dry Fawn Bench

This project was started by the U. S. Forest Service and transferred to A. R. S.

Ten control treatments were applied in 1951 on big sagebrush. Plots 30 feet by 80 feet were replicated twice. Spraying was done in July with 2,4-D at three pounds of acid equivalent per acre. All seeded plots were broadcast with crested wheatgrass at 18 pounds per acre.

In 1955 an ocular estimate of percent kill of sagebrush, percent cover of sagebrush, and percent of herbage utilized was made. The 1955 data and correlations between percent sagebrush cover and utilization of herbage are presented in the 1955 annual report.

An ocular estimate of sagebrush reinvasion was made September 18, 1956. Data is presented in table 22. Differences between treatments on reinvasion of sagebrush were non-significant. However, it would appear that greater control was received from fall burn combinations; and reinvasion by seedling sagebrush was also low on plots controlled by fall burning. Spring burning and spring disking treatments apparently favored or did less to reduce reinvasion.

Excessive gopher damage was observed in open areas and under dead sagebrush. Very little damage was seen under mature plants. There was some indication that burrowing by gophers was more extensive in burned areas than unburned. Since damage done by gophers is a major range problem in

certain areas, these observations may give some lead to their activities and be investigated further.

The percent of grass cover was approximately the same for all plots regardless of sagebrush density; and was more directly affected by gopher mounds and burrows than by sagebrush density.

The entire area had been grazed by cattle. Though grass cover appeared the same for all plots, the forage utilitzation was inversely proportionate to the density of sagebrush. This observation was also recorded in 1955 and supported by correlation of that data.

Table 22. Control of sagebrush and reinvasion after five seasons of growth. Dry Fawn Bench, Beaverhead National Forest, Montana.

Treatment	Kill of Sagebrush	Percent of Area Covered		
		Mature Sagebrush	Seedling Sagebrush	Total Sagebrush
	(Percent)			
Sprayed	50	15	5	20
Untreated - seeded	trace	33	1	34
Untreated	trace	35	1	36
Sprayed - seeded	80	8	7	15
Fall burn - seeded	95	1	2	3
Spring disked - seeded	65	10	25	35
Fall burn	95	1	6	7
Summer burn - seeded	40	18	7	25
Summer burn	30	23	6	29
Spring burn - disk - seeded	83	4	14	18

GRAZING MANAGEMENT OF DRYLAND PASTURES
FORT ELLIS, MONTANA

Five grass species were seeded in triplicate acre lots at Fort Ellis in 1950. The pastures were protected from grazing in 1951.

In 1952 the pastures were grazed continuously from May 28 to October 29 by yearling ewes. The sheep on crested and intermediate wheatgrasses were below maximum seasonal weight on October 29. The sheep on the other grasses were at their maximum weight at that time.

In 1953 the pastures received continuous grazing from May 18 to October 20, except pubescent wheatgrass which was grazed to September 8.

In 1954 an attempt was made to divide each lot into two pastures by means of an electric fence. One pasture was to have been grazed continuously and the other in a rotational system. It was impossible to hold the sheep under an electric fence. At the end of the first rotational period all lots were grazed continuously for the rest of the season. The pastures were grazed from May 13 to October 5.

In 1955 permanent net wire fences were used to divide the lots into two similar 1/2 acre pastures. One was continuously grazed. The other was grazed in rotation with lots from replications of the same species. Grazing extended from May 13 through October 12.

In 1956 grazing extended from May 23 through August 29 except for big bluegrass which was grazed from May 16. The numbers of sheep on pasture varied through the season and were adjusted to the carrying capacity of the pastures. Sheep were to have been removed when forage was fully utilized.

It is questionable if the sheep were removed when this point was reached. From the pounds of animal gain or loss, table 23, it would appear that for maximum production the sheep should have been removed at the end of the fourth grazing period (July 18) on intermediate wheatgrass and at the end of the fifth grazing period (August 1) for most of the other species. At these periods, however, considerable mature, stemmy herbage remained in the pastures. The quality of this herbage was reflected in chemical analyses for protein.

A summary of the 1956 grazing data, table 24, shows continuous grazing to be generally superior to rotational grazing in pounds of animal gains and TDN. Observation of the grazed pastures would indicate that the difference is partially due to the quality of forage available for grazing. On rotational grazing the sheep were turned into pastures of coarse, mature grass. The grazing cycle was 14 days on and 28 days off pasture which would give the plants 28 days to grow before they were to be grazed again. On continuous grazing the sheep were ingesting tender green leaves throughout the season, hence, were getting forage of higher quality.

This observation is also backed by the presence of heavy spot grazing in the continuously grazed pastures. The stocking rates were such that animals were not forced to graze the pastures uniformly. As a result, large areas of grass were allowed to mature and were grazed only lightly at the expense of small heavily grazed patches. Many of the plants in these spots were killed or reduced in vigor.

Considerable variation in herbage production occurred between replicates. The pastures which were fully utilized early in 1956 were the same utilized early in 1955. This variation between replicates strongly indicates field variations in soil moisture, soil fertility, or a combination of environmental factors.

A summary of continuously grazing data for the 5-year period is given in table 25.

Sherman big bluegrass was generally ready to graze before the other species and was as much as a week ahead of crested wheatgrass. It matured early in the growing season if not closely grazed. When grazing was close enough to prevent heading, green forage was available throughout the season. In the fall of the year big bluegrass started regrowth sooner than the other grass and went into the winter green. The green color of the pastures was noted late in December of 1956 after intermittent freezing and snow storms. Over the five-year period big bluegrass compared closely with tall wheatgrass in carrying capacity, animal gains, and TDN. These two species were the high producers.

Tall wheatgrass was ready to graze approximately 2 to 3 weeks after big bluegrass. It produced an abundance of coarse forage. Regardless of its coarse appearance this grass was taken fairly well by sheep. It stayed green later in the season than the other grasses. This factor is reflected in the protein content of the herbage.

Standard crested wheatgrass was ready to graze early in the spring though not as early as big bluegrass. Though it matured early in the summer sheep continued to gain until the last of August. Generally sheep lost weight after that date though they appeared full. The pastures of crested wheatgrass were the first to be fully utilized.

Intermediate and pubescent wheatgrasses were ready for grazing from 1 to 2 weeks after crested wheatgrass. Intermediate surpassed pubescent in average number of sheep days and TDN but fell below pubescent in pounds of daily animal gains and pounds of gain per acre. For most years sheep on

intermediate wheatgrass were below their maximum seasonal weight at the end of the grazing season, while sheep on the other grasses were at or near their maximum seasonal weight.

From observations and data compiled over the 5 years of grazing, it is apparent that different forage species must be managed and grazed in different manners. Factors of particular importance to be considered in grazing management are:-

1. date at which the grass is ready for spring grazing
2. rate at which growth and development takes place
3. rate of stocking
4. class of animals
5. stage of growth
6. percent of utilization at which animals should be removed from grazing

Maximum herbage and animal gains will not be obtained if these factors are not considered in determining the management practices. It is also apparent that maximum yields were not obtained in this study because certain of these factors were not known.

Table 23. Pound of animal gain or loss from yearling ewes on grass pastures at Fort Ellis, Montana, 1956.

Pasture	Grazing system	Grazing Period							
		1	2	3	4	5	6	7	Total
		(Pounds per acre)							
Pubescent wheatgrass	continuous	46	17	24	21	5	-2	9	120
	rotation	32	-1	14	35	-2	7	7	92
Tall wheatgrass	continuous	76	14	28	31	2	-9	14	156
	rotation	69	4	58	1	3	-2	12	145
Big bluegrass	continuous	92	-5	22	33	14	-10	8	154
	rotation	80	-14	4	42	-12	-12	29	117
Crested wheatgrass	continuous	99	15	62	4	3	-4	3	182
	rotation	71	19	14	35	-21	12		130
Intermediate wheatgrass	continuous	83	22	31	40	-5	-1	-32	138
	rotation	82	0	48	16	-11	5	2	142

Table 24. Summary of 1956 grazing data on dryland grass pastures at Fort Ellis, Montana.

Species	Grazing system	Days on pasture	Sheep days per acre	Pounds gain per acre	Pounds daily gain per animal	TDN Equivalent to alfalfa hay - tons per acre
Pubescent wheatgrass	continuous	98	392	120	0.31	1.04
	rotation	98	392	92	0.02	.92
Tall wheatgrass	continuous	98	560	104	0.18	1.22
	rotation	98	588	97	0.16	1.25
Big bluegrass	continuous	105	630	103	0.16	1.23
	rotation	105	630	78	0.12	1.18
Crested wheatgrass	continuous	98	488	121	0.24	1.20
	rotation	84	485	87	0.18	1.09
Intermediate wheatgrass	continuous	98	588	92	0.15	1.31
	rotation	98	563	95	0.17	1.23
Average	continuous	99	505	100	0.21	1.13
	rotation	97	505	84	0.13	1.07

Table 25. Summary of 5-years grazing data on dryland pastures at Fort Ellis, 1952 - 1956.

Species	Year	Days on pasture	Sheep days per acre	Pounds gain per acre	Pounds daily gain per animal	TDN equivalent to alfalfa hay - tons per acre
Pubescent wheatgrass	1952	154	462	87	0.19	1.12
	1953	113	678	171	0.25	1.73
	1954	105	630	83	0.13	1.51
	1955	133	495	120	0.24	1.26
	1956	98	392	120	0.31	1.04
	AVERAGE	121	531	116	0.22	1.33
Tall wheatgrass	1952	154	462	105	0.23	1.22
	1953	155	930	148	0.15	2.08
	1954	147	882	77	0.09	1.81
	1955	133	798	124	0.16	1.79
	1956	98	560	104	0.18	1.22
	AVERAGE	137	726	112	0.16	1.62
Big bluegrass	[illegible]	154	462	87	0.19	1.14
	[illegible]	155	930	150	0.19	2.18
	[illegible]	133	798	90	0.11	1.75
	1955	149	862	132	0.15	1.91
	1956	105	630	103	0.16	1.23
	AVERAGE	139	736	112	0.16	1.64
Standard crested wheatgrass	1952	154	462	68	0.15	1.09
	1953	155	930	140	0.14	2.01
	1954	119	704	46	0.07	1.40
	1955	149	778	136	0.17	1.81
	1956	98	488	121	0.24	1.20
	AVERAGE	135	672	102	0.15	1.50
Intermediate wheatgrass	1952	154	462	69	0.15	1.06
	1953	155	930	135	0.11	1.95
	1954	119	704	50	0.07	1.42
	1955	133	742	130	0.18	1.72
	1956	98	588	92	0.15	1.20
	AVERAGE	132	685	95	0.13	1.47

FCc9-7: Nutritive Value and Chemical Composition of Grasses and Legumes as Affected by Different Cultural and Harvesting Practices.

Protein Content of Native Forage from Fertilized Rangeland in Montana

Samples of herbage harvested for determination of yield on fertilized plots of native rangeland were analyzed for protein content. The analyses are given in table 26.

Significant differences in protein content was shown for fertilizer treatments at all locations but Ennis. The non-significance of treatment differences at Ennis were suspected since no visual change in vegetative color was observed. From the data, however, there is an indication that there may have been a slight response to the nitrogen with phosphate treatments though the differences were not great enough to be significant.

Herbage samples from Three Forks were high in protein content, even from plots receiving no nitrogen. Though the bluegrass was dry and ripe, the sedge and western wheatgrass were green. This green forage and the ripe bluegrass seed may have resulted in the high protein analysis.

Figure 6 shows the graphic response of native vegetation at Crockett Lake to fertilization as measured by protein content of the herbage. The graph would indicate that the addition of phosphate decreased protein content when applied with 50 pounds per acre of nitrogen, but increased protein when 80 pounds P_2O_5 were applied with Nitrogen at rates of 100 pounds per acre or greater.

The content of protein in the herbage at Lazymans Hill shows a response similar to that at Crockett Lake. An increased rate of nitrogen application caused an increase in the protein content of the herbage.

Table 26. Content of crude protein in native forage as influenced by fertilization, 1956.

Treatment lbs./acre		Location and date			
		Three Forks[1] June 25	Ennis[2] July 24	Crockett Lake[3] July 25	Lazymans Hill[4] August 28
N	+ P_2O_5	(percent N x 6.25)			
0	0	9.2	5.5	5.9	8.3
50	0	7.7	5.1	7.5	10.0
100	0	10.9	5.2	8.2	11.3
200	0	11.8	5.1	9.4	12.4
400	0	11.0	5.7	10.4	15.8
0	20	6.4	4.5	5.5	7.7
50	20	10.1	5.0	7.1	10.0
100	20	11.0	4.9	8.1	10.8
200	20	9.5	5.1	9.4	13.3
400	20	11.3	5.7	10.4	15.0
0	80	8.5	4.9	5.9	7.5
50	80	10.5	5.2	6.9	10.3
100	80	9.2	5.1	8.6	12.5
200	80	10.4	5.5	9.4	15.0
400	80	11.8	5.3	10.7	16.1
L.S.D. at 5% level		1.4	N.S.	0.5	0.3
C. V.		61%	45%	7%	10%

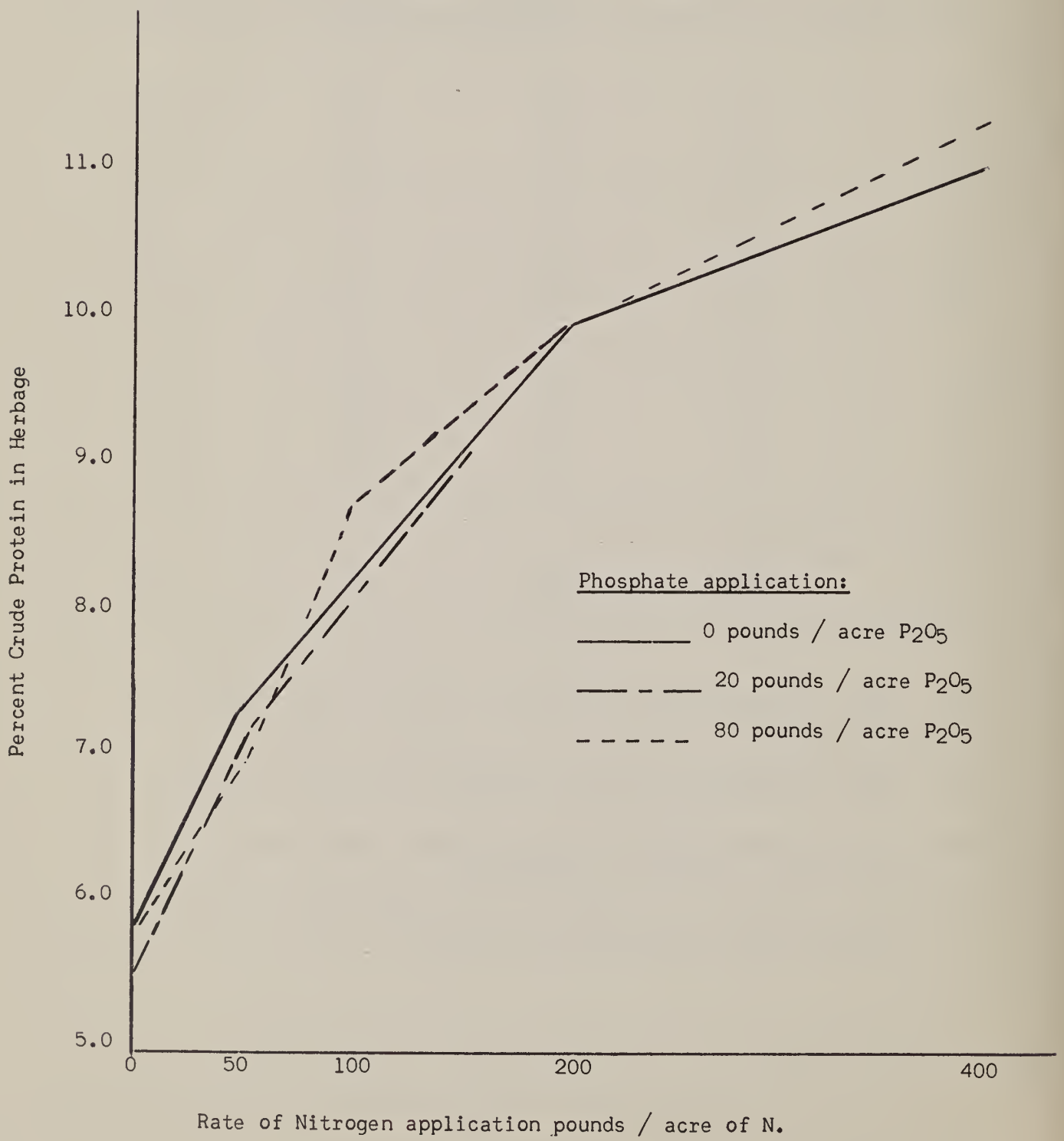
1./ Plots of a bluegrama -- bluegrass -- stipa -- sedge complex were fertilized April 12, 1956. Elevation is 4500 feet.

2./ Plots of bluegrass -- stipa -- sedge complex were fertilized June 6, 1956. Elevation is 6000 feet.

3./ Plots of Idaho fescue -- wheatgrass complex were fertilized May 18, 1956. Elevation is 7500 feet.

4./ Plots of fescue -- wheatgrass -- forb complex were fertilized June 26, 1956. Elevation is 9350 feet.

Figure 6. Effect of various fertilizer rates on protein content of native vegetation. Crockett Lake, Montana, 1956.



PROTEIN CONTENT OF DRYLAND GRASSES

Herbage samples were taken at intervals through the grazing season of 1956 and analyzed for protein content. Analyses are shown in table 28.

A curvilinear decline in protein was expressed for all grasses as the season advanced. Big bluegrass was lowest in protein in June but intermediate wheatgrass was lowest in August. Tall wheatgrass was highest in protein content at the end of the grazing season and was closely followed by pubescent wheatgrass.

The data would indicate that the protein content of herbage was higher on rotationally grazed pastures than on continuously grazed and follows the same comparison as the 1955 data. It should be understood, however, that the herbage collected may not represent true samples of the forage actually ingested and that the sheep were actually ingesting forage of higher quality. This is somewhat indicated since sheep gains were higher on the continuously grazed pastures than on the rotationally grazed. The spot grazing of the continuously grazed pastures would also indicate that the sheep were getting the new regrowth as soon as it was long enough to graze.

Table 28. Protein content of grasses grown under dryland conditions. Fort Ellis, Montana, 1956.

Species	Grazing system	Date of sampling 6/14	7/11	8/8	8/31
		(percent N x 6.25)			
Pubescent wheatgrass	continuous	10.6	9.2	5.1	4.2
	rotation	15.1	8.4	5.2	4.6
Tall wheatgrass	continuous	7.5	9.1	7.2	4.5
	rotation	10.5	9.6	6.8	4.4
Big bluegrass	continuous	7.5	5.6	4.1	3.2
	rotation	7.9	5.6	4.7	3.5
Crested wheatgrass	continuous	8.5	7.3	4.8	3.3
	rotation	10.7	8.6	6.0	4.5
Intermediate wheatgrass	continuous	8.6	6.6	3.6	2.8
	rotation	10.8	7.2	4.2	2.9

SUMMARY

1. Seed Production of Bromegrass: Nitrogen applied to smooth bromegrass at seeding time failed to increase the yield of seed. Differences in production have been related to variety rather than fertilizer applications. Montana I and II and Manchar have been the high producers over a 3-year period. Manchar has increased each year while Lincoln and the New York selections have decreased.

2. Hay Yields Under Irrigation: Environmental factors have influenced yield of bromegrass more than variety. Ammonium nitrate was applied in 1956 to study the response to nitrogen fertilization on both bromegrass and orchardgrass yields. Over a 3-year period a commercial variety of orchardgrass and the Elsberry strain of bromegrass have been high producers. In 1956 the Oklahoma selection of brome and commercial orchard were high producers.

3. Hay Yield on Dryland: Over a 5-year period Lincoln smooth brome has been high yielder. In 1956 standard crested wheatgrass and intermediate wheatgrass were the highest producers at Fort Ellis with 18-inches of precipitation. At Three Forks with less than 10-inches of precipitation Nordan crested wheatgrass was the superior yielder.

4. High Altitude Adaptation Studies: Percent stand of seedings made in Carrot Basin in 1952 showed Lincoln smooth brome and meadow foxtail to be the better species for an overall seeding program. Stands of grass were superior on south-facing slopes and poorest on north exposures. Correlation is shown between the 1956 stands and herbage yields taken in 1954, but are opposite to seedling counts made in 1953. This would indicate that

many of the seedlings on the level and north sites were winter-killed.

The seeding and fertilization study started in 1955 showed a detrimental effect of nitrogen on the number of seedlings per square foot. Evidentally the rate or method of fertilization or both were adverse to seedling germination.

A final summary of the 1942 species adaptation study at Lazyman Hill was made. After 13 years smooth bromegrass, meadow foxtail, and Kentucky bluegrass appeared well adapted to the high altitude. These species had spread beyond the plot borders and invaded other plots. Meadow foxtail was the only species that showed definite signs of reseeding itself. The study at an elevation of 9350 feet was plowed out in 1956.

5. Fertilization of Native Rangeland: A new study was started to compare 15 fertilizer treatments at 4 locations. The response to treatments varied with location and species. On drier sites, maximum yield was generally obtained from application of 100 pounds N with 80 pounds P_2O_5 per acre. On the more moist sites at higher elevations, 200 pounds N with 20 pounds P_2O_5 gave maximum yields. Application of 400 pounds of nitrogen caused burning of Idaho fescue and killed many plants at Lazyman Hill.

6. Reseeding on Sagebrush Rangeland: At Dry Fawn Bench on the Ruby River, percent stand of species showed smooth brome, intermediate wheatgrass, and hard fescue to be best adapted. Species which showed poor adaptation after 5 years were green stipa, orchardgrass, Russian wildrye, and slender wheatgrass. The importance of brush control and elimination of competition was shown by the superior stands on the more intensively disked plots.

New studies in reseeding of sagebrush rangeland were started in the Horse Prairie Drainage in Beaverhead County. Five species were seeded alone and in mixtures with and without fertilization. The study is designed to determine grazing resistance and palatability of the species and mixtures when fertilizer is applied with seeding.

7. Irrigated Pastures: Three pasture mixtures were compared with 21-day and 42-day rotational periods for the second year. The brome-trefoil mixture was superior in total pounds of animal gains and TDN produced per acre. The 21-day rotational period showed the most pounds of gain on the Huntley and the brome-trefoil mixtures, but was considerably below the 42-day rotation on brome-alfalfa.

8. Dryland Pastures: Five years of grazing on five grass species showed Sherman big bluegrass and tall wheatgrass to be the high producers in carrying capacity, animal gains, and TDN. Big bluegrass was ready for grazing earliest in the season and as much as a week ahead of crested wheatgrass. It also went into the winter greener than the other species. During late summer, tall wheatgrass was the greenest. Crested wheatgrass was the first to be utilized to the extent that sheep had to be removed from grazing. Intermediate and pubescent wheatgrass were the low producers. For most years sheep on intermediate were below their maximum seasonal weight at the end of the grazing season.

9. Protein Content of Forage as Affected by Cultural Practices: Significant differences in protein content was shown for fertilizer treatments on native range at all locations but Ennis. The lack of response at Ennis was possibly a reflection of the available precipitation. The rainfall was extremely low after the plots were fertilized. At the other

locations, protein content increased with increased rates of nitrogen.

The protein content of herbage from irrigated pasture mixtures was higher at the beginning of a rotational period than when the sheep were removed 7 days later. There was little difference between systems of grazing on protein content of the brome-alfalfa mixture while the trend was toward lower protein content on the 21-day rotation of the other mixtures. This trend is the reverse to protein analyses for 1955.

On dryland pastures the protein content of the herbage showed a curvilinear decline for all grasses as the season advanced.